In the Claims

The current status for all of the claims in the present application is provided.

1. (Original) Ion optical apparatus for producing a low energy ion beam, the ion beam having a beam plasma at a final ion beam energy, said apparatus comprising:

an acceleration electrode for accelerating the ion beam;

a deceleration electrode downstream of said acceleration electrode for decelerating the ion beam, said deceleration electrode having a voltage that is selected to provide a potential barrier to thermal ions in the beam plasma to inhibit thermal ions from reaching said acceleration electrode; and

an ion optical element downstream of said deceleration electrode for inhibiting electrons in the beam plasma from reaching said deceleration electrode.

2. (Original) Ion optical apparatus as defined in claim 1 wherein the ion beam has a beam axis and wherein the deceleration electrode voltage is selected such that the potential on the beam axis near said deceleration electrode is at least slightly positive with respect to the potential of the beam plasma.

3. (Original) Ion optical apparatus as defined in claim 1 wherein said ion beam has a beam axis and wherein said ion optical element comprises a electron repulsing electrode having a voltage that is selected such that the potential on the beam axis near the electron repulsing electrode is at least slightly negative with respect to the potential of the beam plasma.

4. (Original) Ion optical apparatus as defined in claim 1 wherein said ion optical element comprises a magnetic element for producing a magnetic field.

5. (Original) Ion optical apparatus as defined in claim 4 wherein said deceleration electrode is shaped to limit on axis electric fields.

6. (Original) Ion optical apparatus as defined in claim 1 wherein the aperture of said deceleration electrode is larger than the aperture of said acceleration electrode.

7. (Original) Ion optical apparatus as defined in claim 1 wherein at least one of said acceleration electrode and said deceleration electrode is segmented in a direction lateral to the ion beam to edfine individually controllable electrode segments.

8. (Original) Ion optical apparatus as defined in claim 1, implemented as an ion source extraction system.

9. (Original) Ion optical apparatus as defined in claim 1, implemented as a deceleration lens system.

10. (Original) A method for producing a low energy ion beam, the ion beam having a beam plasma at a final ion beam energy, said method comprising the steps of:

accelerating the ion beam with an acceleration electrode;

decelerating the ion beam a deceleration electrode downstream of the acceleration electrode;

biasing the deceleration electrode at a voltage that is selected to provide a potential barrier to thermal ions in the beam plasma to inhibit thermal ions from reaching the acceleration electrode; and

inhibiting electrons in the beam plasma from reaching the deceleration electrode with an ion optical element downstream of said deceleration electrode.

11. (Original) A method as defined in claim 10 wherein the ion beam has a beam axis and wherein the step of biasing the deceleration electrode comprises selecting the

deceleration electrode voltage such that the potential on the beam axis near the deceleration electrode is at least slightly positive with respect to the potential of the beam plasma.

12. (Original) A method as defined in claim 10 wherein the ion beam has a beam axis and wherein the step of inhibiting electrons in the beam plasma from reaching the deceleration electrode comprises selecting the electron repulsing electrode voltage such that the potential on the beam axis near the electron repulsing electrode is at least slightly negative with respect to the potential of the beam plasma.

13. (Original) A method as defined in claim 10 wherein the step of inhibiting electrons in the beam plasma from reaching the deceleration electrode comprises inhibiting electrons with a magnetic element which produces a magnetic field.

14. (Original) A method as defined in claim 13 further comprising the step of segmenting at least one of the acceleration electrode and the deceleration electrode in a direction lateral to the ion beam.

15. (Original) A method as defined in claim 10 further comprising the step of segmenting at least one of the acceleration electrode and the deceleration electrode in a direction lateral to the ion beam.

16. (Currently Amended) Ion optical apparatus for producing a low energy ion beam, said apparatus comprising:

an acceleration electrode for accelerating the ion beam; and

a deceleration electrode downstream of said acceleration electrode for decelerating the ion beam to form the low energy ion beam, at least one of said acceleration electrode and said deceleration electrode being segmented in a direction lateral to the ion beam to define individually controllable electrode segments, said electrode segments having independent voltages applied thereto for adjusting the density and focus of desired parts of the ion beam.

17. (Original) An ion extraction system or a deceleration lens system for producing low energy beams, said system comprising:

an acceleration electrode;

a deceleration electrode, the voltage between the acceleration electrode and the deceleration electrode being 5 keV or more; and

a beam plasma formed at a final ion beam energy and comprising thermal positive ions and electrons,

the deceleration electrode having a voltage more positive than the final beam energy to prevent most of the thermal positive ions in the said beam plasma from going to the said acceleration electrode, and

the system further comprising means for preventing most of the electrons in the said beam plasma from going to the deceleration electrode.

18. (Original) The apparatus of claim 17, where the means for preventing most of the electrons in the said beam plasma from going to the deceleration electrode is an electron repulsing electrode downstream of the deceleration electrode.

19. (Original) The apparatus of claim 17, wherein the means for preventing the electrons from going to the deceleration electrode is magnetic.

20. (Original) The apparatus of claim 17, wherein the deceleration electrode is segmented in a longitudinal direction relative to the beam line, the segments thereof having different voltages applied thereto.

21. (Original) The apparatus of claim 17, wherein the acceleration electrode is segmented in a longitudinal direction relative to the beam line, the segments thereof having different voltages applied thereto.

22. (Original) An ion extraction system or a deceleration lens system for producing low energy beams, said system comprising:

an acceleration electrode;

a deceleration electrode, and

a beam plasma formed at a final ion beam energy,

wherein the acceleration electrode is segmented in a direction transverse to the beam line, the segments thereof having different voltages applied thereto.

23. (Original) An ion extraction system or a deceleration lens system for producing low energy beams, said system comprising:

an acceleration electrode;

a deceleration electrode, the voltage between the said acceleration electrode and the said deceleration electrode being 5 keV or more; and

a beam plasma formed at a final ion beam energy,

the deceleration electrode having a voltage which is positive relative to the acceleration electrode and the final beam energy, and the system further comprising

an electron repulser downstream of the deceleration electrode, the electron repulser being either

an electrode having a voltage which is negative relative to the decleration electrode voltage and the final ion beam energy and positive relative to the acceleration electrode voltage; or

a magnet providing a field configured to substantially prevent electrons in the ion beam from diversion to the deceleration electrode.

24. (Original) A method of increasing or varying the focal properties of a deceleration lens or extractor apparatus comprising an acceleration electrode, a deceleration electrode and a beam line, the method comprising varying the potential on the deceleration electrode transversely relative to the beam line to effect an increase or variance in the focal properties of said deceleration lens or extractor apparatus.

25. (Original) A method of obtaining a less divergent ion beam at the wafer of an ion implantation system, said method comprising passing the beam through a deceleration lens apparatus comprising an acceleration electrode and a deceleration electrode, wherein the acceleration and/or the deceleration potential on said electrode or electrodes is varied transversely with respect to the beam line to effect correction of beam divergence of density at said wafer.

26. (Original) An extraction or deceleration ion lens apparatus containing at least an acceleration electrode and a deceleration electrode,

at least one of said acceleration and deceleration electrodes being segmented and having different voltages applied to said segments to provide better focal and density properties of the ion beam.

27. (Original) The apparatus of claim 26, where both the acceleration and deceleration electrodes are segmented.

28. (Original) The apparatus of claim 26, further comprising an electron repulsion electrode and a final beam plasma, and the electron repulsion electrode having a voltage sufficiently negative to substantially prevent electrons from being pulled out of the final beam plasma to the deceleration electrode.